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Classifying risk status of non-clinical adolescents using psychometric indicators for psychosis spectrum disorders

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ABSTRACT

This study is an attempt to evaluate extant psychometric indicators using latent profile analysis for classifying community-derived individuals based on a set of clinical, behavioural, and personality traits considered risk markers for psychosis spectrum disorders. The present investigation included four hundred and forty-nine high-school students between the ages of 12 and 19. We used the following to assess risk: the Prodromal Questionnaire-Brief (PQ-B), Oviedo Schizotypy Assessment Questionnaire (ESQUIZO-Q), Anticipatory and Consummatory Interpersonal Pleasure Scale-Adolescent version (ACIPS-A), and General Health Questionnaire 12 (GHQ-12). Using Latent profile analysis six latent classes (LC) were identified: participants in class 1 (LC1) displayed little or no symptoms and accounted for 38.53% of the sample; class 2 (LC2), who accounted for 28.06%, also produced low mean scores across most measures though they expressed somewhat higher levels of subjective distress; LC3, a positive schizotypy group (10.24%); LC4 (13.36%), a psychosis high-risk group; LC5, a high positive and negative schizotypy group (4.45%); and LC6, a very high distress, severe clinical high-risk group, comprised 5.34% of the sample. The current research indicates that different latent classes of early individuals at risk can be empirically defined in adolescent community samples using psychometric indicators for psychosis spectrum disorders. These findings may have implications for early detection and prevention strategies in psychosis spectrum disorders.

1. Introduction

High-risk studies provide a framework for identifying risk factors and establishing the predictive validity of schizophrenia and psychosis indicators (Cornblatt, 2002). For example, genetic high-risk studies indicate that family history, attentional deviance, cognitive impairments, thought disorder, and social deficits are risk factors for schizophrenia-related psychoses (Cornblatt et al., 1999; Parnas, 1999; Erlenmeyer-Kimling et al., 2000; Tarbox and Pogue-Geile, 2008; Gooding et al., 2013). Psychometric high-risk studies suggest that schizotypal traits (e.g., perceptual aberrations and magical ideations) are risk factors for psychotic disorders in general (Chapman et al., 1994), whereas social anhedonia, the diminished ability to experience pleasure in the interpersonal domain, is associated with heightened risk for the development of schizophrenia-spectrum disorders (Kwapil, 1998; Gooding et al., 2005, 2007). These genetic and psychometric high-risk studies have, in turn, informed and inspired the next generation of studies, namely, the clinical high-risk (CHR) studies aimed at the early identification of early and late (prodromal) risk factors.

Given that not all individuals who are at heightened risk for the later development of schizophrenia and psychosis manifest disorder, the need for early and reliable clinical indicators becomes more pressing. Individuals who develop psychosis and psychosis-spectrum disorders are often preceded by a period of variable duration, during which there is a marked decline in functioning. Individuals experiencing these often nonspecific symptoms are said to be undergoing a "prodromal state"; perhaps more accurate terms for "prodromal status" are "ultra high risk", "clinical high

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risk", or "at risk mental state", because in medical nomenclature, prodromal implies that conversion to disorder is imminent (e.g., Fusar-Poli et al., 2014).

Prodromal symptoms and clinical indicators, whether identified via the basic symptom approach (Ruhrmann et al., 2010) or through application of ultra-high-risk (UHR) criteria (Miller et al., 2003; Yung et al., 2005), typically include psychotic-like experiences, attenuated positive symptoms, attenuated negative symptoms, intermittent psychotic symptoms, and functional decline in combination with genetic risk indicators. Moreover, CHR are also a key factor in terms of the prediction of clinical psychosis, and have been related to nonpsychotic psychopathology, social impairments, neurocognitive performance impairments, and/or structural and neurochemical alterations (Yung and McGorry, 1996; Cornblatt et al., 2003; Fusar-Poli et al., 2012, 2013, 2014, 2015; Carríon et al., 2013). Consistent with the developmental psychopathology construct of equifinality, the etiological pathways towards schizophrenia-related psychoses and/or psychosis spectrum disorders are heterogeneous (Gooding and Iacono, 1995). Indeed, investigators such as Cornblatt et al. (2003) have identified several distinct risk groups who display different clusters of deficits associated with adverse psychiatric outcomes, including a CHR group without attenuated psychotic symptoms.

The typical onset of prodromal symptoms is during adolescence, a period associated with considerable neuroplasticity as well as considerable affective and social development (Casey et al., 2008). Moreover, adolescence is a developmental period associated with heightened risk for the onset of psychosis-spectrum disorders (Harrop and Trower, 2003; Schimmelman and Schultze-Lutter, 2012). The prodromal period has been regarded by many to be a targeted window of opportunity in terms of timely prophylactic intervention (Lieberman et al., 2001). Indeed, halting or delaying the progression of psychosis during adolescence may be critical in terms of better patient outcomes (Strobl et al., 2012). Reliable identification of classes or subtypes of individuals at risk for psychosis spectrum disorder, particularly during the time of greatest risk of onset, may help elucidate possible risks and protective factors.

There have been several attempts to identify risk factors and indicators for psychosis and psychosis-spectrum disorders, especially schizophrenia-spectrum disorders. Prior research has supported the predictive value of schizotypal measures (Chapman et al., 1994; Miettunen et al., 2011; Salokangas et al., 2013), prodromal states (Cornblatt et al., 2003; Nelson et al., 2011; Addington and Heinssen, 2012), and anhedonia, especially social anhedonia (Kwapil, 1998; Davidson et al., l999; Gooding et al., 2005, 2007; Miettunen et al., 2011). Despite extensive study of these risk factors, predictors, and precursors associated with psychosis and psychosis spectrum disorders, few studies have attempted to empirically identify latent profiles using a combination of psychometric risk indicators on general community samples.

A relatively new measurement approach, namely, latent profile analysis (LPA; Muthén and Muthén, 1998–2012), is a form of latent class analysis (McCutcheon, 1987) that tests for the existence of discrete groups with similar profiles using continuous indicators (Hori et al., 2014). A few earlier studies (Cella et al., 2013; Geng et al., 2013; Tabak and Weisman de Mamani, 2013; Hori et al., 2014) utilized LPA in order to identify patterns of subclinical psychotic experiences in nonclinical samples. However, with the exception of Cella et al. (2013), the investigations focused on adult samples. While Geng et al. (2013) and Tabak and Weisman de Mamani (2013) relied upon undergraduate samples using the SPQ (Raine, 1991) and O-LIFE (Mason et al., 1995), respectively, Hori et al. (2014) studied adults with a mean age of 48 years using the SPQ.

Using a large sample (N=1023) of adolescents, Cella et al. (2013) assessed subjective schizotypal traits as well as psychological distress. They found a three-class solution, including a low schizotypy class, an unusual subjective experiences class, and a 'true schizotypy' class. However, one possible limitation of the Cella et al. (2013) investigation is that they did not also examine the co-occurrence of attenuated positive symptoms, using measures of self-reported CHR symptoms or screens of psychosis-risk. It is noteworthy that the mean age of the Cella et al. (2013) sample was 17.3 ($\pm$ 1.3 years), yet the primary measure used in the research was the short form of the O-LIFE (Mason et al., 2005), which was not developed specifically for use with an adolescent population.

Relatively little is known regarding the frequencies of these symptoms and indicators in the general adolescent population (Schimmelmann et al., 2011). To date, most of the studies of CHR symptoms and clinical indicators of incipient psychosis have been based upon studies of clinic-referred, help-seeking individuals. The eventual goal is to develop applicable psychosis risk screening measures for use in general population samples. The aim of the present study is to evaluate extant psychometric indicators using LPA as a relatively novel framework for classifying community-derived adolescents in terms of the presence of risk indicators for psychosis-spectrum disorders. We sought to combine the strengths of two approaches, namely, the traditions of the psychometric high-risk approach (e.g., schizotypy) and the clinical early intervention approach (e.g., self-reported CHR symptoms), using measures developed specifically for use with adolescent samples. Based upon findings from both lines of research, we hypothesized the following:1) Using LPA, we would be able to empirically identify different psychometric profiles; 2) the profiles would be differentially characterized by variations in terms of self-reported CHR symptoms and/or psychotic-like experiences, trait schizotypy, and subjective mental distress; and 3) using the psychometric profiles based upon LPA, we would be able to define distinct homogenous classes of individuals who varied in terms of levels of putative risk of developing psychosis spectrum disorders.

2. Method

2.1. Participants

In order to obtain a representative community sample, we recruited participants from different cities and different types of secondary schools (e.g., public, funded, and private) belonging to Principality of Asturias, a region located in the north of Spain. Both rural and urban areas were represented, as well as a range of socioeconomic levels. Some of the institutions were technical/vocational (n=4), whereas some were preparatory (secondary or higher) schools from rural areas (n=3), and three were preparatory schools located in urban areas.

The initial sample included 518 students. We omitted participants whose age was outside the range (i.e., younger than 13 or older than 19 years-old (n=16); and/or whose total score on the Infrequency scale was higher than 3 (n=43). The sample consisted of 449 students, including 251 males (55.9%). The age of the participants ranged from 13 to 19 years-old (M=15.14 years; SD=1.47). The age distribution of the sample was as follows: 13 years (n=7; 1.6%), 14 years (n=196; 43.7%), 15 years (n=110; 24.5%), 16 years (n=69; 15.4%), 17 years (n=23; 5.1%), 18 years (n=17; 3.8%), and 19 years (n=27; 6.0%).

2.2. Instruments

The choice of particular measures to include in our assessment reflect our simultaneous goals of wanting to combine a psychometric and CHR approach, as well as utilize measures that were

developmentally appropriate and/or constructed especially for use with adolescents. In order to encompass the CHR approach, we chose the Prodromal Questionnaire-Brief (PQ-B). However, in recognition that negative schizotypy features such as anhedonia frequently precede psychotic symptoms (Cornblatt et al., 2003) and predict schizophrenia-spectrum outcomes (Kwapil, 1998; Gooding et al., 2005; Gooding et al., 2007; Miettunen et al., 2011), we also chose to include a measure of social anhedonia, namely, the Anticipatory and Consummatory Interpersonal Pleasure Scale, Adolescent Version (ACIPS-A). In order to incorporate the psychometric high-risk approach from a developmentally appropriate perspective, we chose the Oviedo Schizotypy Assessment Questionnaire (ESQUIZO-Q). In order to study self-reported subjective and psychological well-being, we used the 12-item General Health Questionnaire (GHQ-12). Subclinical psychotic experiences and symptoms such as schizotypal traits may have more predictive validity if they are accompanied by mental distress. Thus, mental discomfort, as assessed by the GHQ-12, may be relevant in terms of predicting the transition to psychosis. These measures are described, below.

Prodromal Questionnaire–Brief (Loewy et al., 2011). The PQ-B is a questionnaire-based screening measure containing 21-items that are answered in a dichotomous response format (true/false). The PQ-B asks additional questions regarding extent/severity of impairment and distress, and is rated on a Likert-type (1 "strongly disagree" to 5 "strongly agree"), in order to improve specificity compared to the original measure. In the brief version of the PQ the authors retained only the items related to the positive dimension as those formed the basis for the prodromal syndromes. The PQ-B is a good measure for screening adolescents and young adults at high clinical risk (Loewy et al., 2011; Kline et al., 2012, 2015; Kline and Schiffman, 2014). In this study, we adopted the validated Spanish adaptation of the PQ-B, which appears to be a valid screening measure for use in nonclinical, community-ascertained samples of adolescents (Fonseca-Pedrero et al., 2016).

Oviedo Schizotypy Assessment Questionnaire (ESQUIZO-Q) (Fonseca-Pedrero et al., 2010). The ESQUIZO-Q is a self-report developed for the assessment of schizotypal traits in adolescents. It is comprised of 51 items with a Likert-type response format in five categories (from 1 "totally disagree" to 5 "totally agree"). Its 10 subscales are derived empirically by means of factor analysis: Ideas of Reference, Magical Thinking, Unusual Perceptual Experiences, Paranoid Ideation, Physical Anhedonia, Social Anhedonia, Odd Thinking and Speech, Odd Behaviour, Lack of Close Friends, and Excessive Social Anxiety. Internal consistency levels for the subscales range from 0.62 to 0.90 and show good convergent with psychopathology measures (e.g,. depression symptoms, personality disorders traits) (Fonseca-Pedrero et al., 2011, 2013).

Anticipatory and Consummatory Interpersonal Pleasure Scale, Adolescent Version (ACIPS-A). The ACIPS (Gooding and Pflum, 2011, 2014a, 2014b) was specifically designed to measure individual differences in hedonic capacity for social and interpersonal pleasure. The adolescent version of the ACIPS (ACIPS-A; Gooding et al., in press) differs from the original adult version in terms of its response options; in order to be more developmentally appropriate, the number of response options was decreased from six to four. Therefore, on the ACIPS-A, the options ranged from 1 ("totally false for me") to 4 ("totally true for me"). Thus, total scores range from 17 to 68, with lower scores indicating greater likelihood of social anhedonia. The ACIPS-A was translated into Spanish in accordance with the international guidelines for test translation and adaptation (Muñiz et al., 2013). This version is similar to the Spanish version of the ACIPS for adults (Gooding et al., 2016); detailed description of its psychometric properties can be found elsewhere (Gooding et al., in press). In the present sample, the internal consistency for the ACIPS-A scores was high (ordinal $\alpha = 0.95$).

General Health Questionnaire-12 (GHQ-12). The 12-item version of the General Health Questionnaire (GHQ-12) (Goldberg and Williams, 1988) is a widely used self-report screen for identifying symptoms of mental distress. Each item is rated on a 4-point Likert-typed format; the positively worded items were rated from 0 ("always") to 3 ("never") and the negative items were rated from 3 ("always") to 0 ("never"). Thus, the total score ranged from 0 to 36, with higher scores indicating higher levels of psychological distress. The psychometric properties of the GHQ-12 are well established (Hankins, 2008; Romppel et al., 2013). We relied upon the Spanish version of the GHQ-12 (López-Castedo and Fernández, 2005; Rey et al., 2014).

The Oviedo Infrequency Scale (INF-OV). The INF-OV (Fonseca-Pedrero et al., 2009) is a 12-item self-report instrument with a Likert-type response format using five categories (from 1 "totally disagree" to 5 "totally agree"). Its objective is to detect those participants who respond to self-reports in a random, pseudo-random or dishonest fashion. Respondents who replied to more than three of these items incorrectly were automatically omitted from further inclusion in study analyses. This cut-off point is based on previous empirical research (Fonseca-Pedrero et al., 2009). (Example item: *The distance between Madrid and Barcelona is greater than the distance between Madrid and New York*).

2.3. Procedure

The questionnaires were administered collectively, in groups of 10–35 students, during normal school hours and in a classroom specially prepared for this purpose. Recruitment was aided by a letter of endorsement from the director of the Educational Department for the Principality of Asturias, which was sent to all the parents and guardians informing them of the project and seeking their consent. The study was described as a study of adolescent health and well-being. For all participants under age 18, parents were asked to provide written informed consent in order for their child to participate in the study. Participants were informed of the confidentiality of their responses and of the voluntary nature of the study. No incentive was provided for participating in the study. Administration took place under the supervision of researchers. The study was approved by the research and ethics committee at the University of Oviedo as well as the Education and Social/Behavioral Sciences Institutional Review Board of the University of Wisconsin-Madison.

2.4. Data analyses

First, we calculated descriptive statistics for the measures we obtained. We also tested the possible effect of age and gender on the variables. We computed Pearson correlation coefficients to examine the associations between measures. In order to test for the existence of discrete groups (classes) with similar psychometric profiles, we conducted exploratory LPA (Muthén and Muthén, 1998–2012). LPA is a form of latent class analysis that is used when working with continuous variables. Exploratory LPA was conducted to identify homogenous latent groups based on PQ-B, ESQUIZO-Q, ACIPS-A, and GHQ-12 scores. In LPA, models are compared to determine the optimal number of classes (i.e., class enumeration), beginning with evaluating the fit of a 1-class model and incrementally adding latent classes until the best class solution has been satisfied.

Model selection is based upon consideration of several fit indices including information criteria and likelihood ratios. In terms of the information criteria such as the Akaike Information Criterion (AIC; Akaike, 1987), the Bayesian Information Criterion (BIC; Schwarz, 1978), and the sample-size adjusted BIC (ssaBICl Sciove, 1987) information criterion statistics, lower values indicate a

better fit. The likelihood ratios of the $k-1$ and k class models test the null hypothesis that there is no statistically significant difference. Thus, a $p<0.05$ suggests that the k class model is a better fitting model than the $k-1$ class model while a $p>0.05$ suggests that $k-1$ class solution is preferred in terms of accurately reflecting the data. We considered the Lo-Mendell-Rubin's adjusted likelihood ratio test (LRT; Lo et al., 2001) as well as a standardized measure of entropy. The entropy measure (values ranging from 0 to 1) assess relative accuracy in participants' classification, with higher values indicating better separation of the identified groups (Ramaswamy et al., 1993). According to Nylund et al. (2005) there is not one commonly accepted statistical indicator for deciding on the number of classes in a study population. In this simulation study they found that whereas the Bayesian Information Criterion (BIC) performed the best of the ICs, the bootstrap likelihood ratio test proved to be a very consistent indicator of classes across all of the models considered. Simulation studies considering LCA models suggest that the adjusted BIC is superior to other information criteria statistics.

After determining the best class solution, mean scores and confidence intervals were computed for each latent class. SPSS 15.0 (Statistical Package for the Scoial Sciences, 2006) and Mplus 7.0 (Muthén and Muthén, 1998–2012) were used for these analyses.

3. Results

3.1. Descriptive statistics

Descriptive statistics for the subscales and total scores of the measures are provided in Table 1. We observed statistically significant gender differences on the No close friends ($t(447)=-2.36$; $p=0.019$), Social anhedonia t (441.3)=2.90; $p=0.003$), Physical anhedonia (t (447)=2.36; $p=0.019$) subscales of the ESQUIZO-Q, as well as on the ACIPS-A (t (445.7)=−5.83; $p<0.001$), and GHQ-12 (t (381.3)=−3.94; $p<0.001$). Male participants scored higher than the females on the Social and Physical anhedonia subscales. Female participants scored higher than the males on the No close friends subscale, ACIPS-A, and GHQ-12 total scores. Age was associated with the Paranoia ($r=0.18$, $p<0.01$), Odd Speech ($r=0.17$, $p<0.01$), Odd Behaviour ($r=0.14$, $p<0.01$), and No close friends ($r=0.18$, $p<0.01$) subscales, as well as the ACIPS-A ($r=-0.13$, $p<0.01$), and GHQ-12 ($r=0.10$, $p=0.04$).

3.2. Relationship between measures

We calculated the association between the PQ-B total, PQ-B Distress, ESQUIZO-Q subscales, ACIPS-A, and GHQ-12 total scores. The resultant correlation matrix is provided in Table 2. Scores on the ESQUIZO-Q Positive and Disorganized dimensions were moderately associated with PQ-B total and PQ-B Distress scores. The ACIPS-A total score were negatively associated with both the ESQUIZO-Q anhedonia subscales. Finally, the GHQ-12 total score was moderately associated with the PQ-B, ESQUIZO-Q Positive subscales, and Lack of close friends subscale scores.

3.3. Latent profile analyses: determination of the number of latent classes

We tested latent profile solutions of one to six classes. Table 3 provides the goodness-of-fit indices for the competing latent class models. We first compared the 1- and 2-class models. The LMR-A p value for the 2-class model reached significance, suggesting that the 2-class model was superior to the 1-class model. We then compared the 2- and 3-class profile models. The LMR-A p value for the 3-class model did not reach significance and the entropy value was low. Considering this evidence, the 2-class model was the better-fitting model. We then compared the 2- and 4-class model. Although the 4-class model was equal in entropy to the 2-class model, it demonstrated a lower AIC, BIC and ssaBIC than the 2-class model. However, we noted the non-significant LMR-A p value of the 4-class model. Consistent with others (Nylund, Asparaouhov, & Múthen, 2007; Hori et al., 2014), we opted to rely more heavily upon the Bayesian information criterion than the LMR-A-LRT p value. Given these criteria, the 5- and 6-class models were plausible. The AIC and ssaBIC also favor the 5- and 6-class solutions over the 4-class solution. Considering the BIC as well as entropy values, the 6-class solution indicated a better fit compared to the other models. As a result, we chose the 6-class model as the better-fitting one. In the 6-class solution, class 1 (LC1) described 38.53% (n=173), class 2 (LC2) 28.06% (n=126), class 3 (LC3) 10.24% (n=46), class 4 (LC4) 13.36% (n=60), class 5 (LC5) 4.45% (n=20), and class 6 (LC6) 5.34% (n=24), of the participants. The average class membership for class 1, class 2, class 3, class 4, class 5 and class 6 was 0.96, 0.92, 0.97, 0.95, 0.98, and 0.97, respectively, indicating good overall discrimination.

Table 1
Descriptive statistics for the scales and subscales (n=449).

	Mean	*SD*	Skewness	Kurtosis	Min.	Max.
PQ-B frequency	5.26	4.39	0.70	−0.15	0	18
PQ-B distress	14.04	13.74	1.17	1.17	0	73
ESQUIZO-Q subscales						
Ideas of reference	6.66	3.27	1.37	1.52	4	20
Magical thinking	8.75	3.82	1.02	0.57	5	25
Unusual perceptual experiences	11.65	5.85	1.39	1.29	7	35
Paranoid ideation	8.17	3.59	1.16	0.72	5	22
Odd speech	13.75	5.61	0.48	−0.60	6	30
Odd behaviour	7.31	3.16	1.02	0.53	4	19
Lack of close friends	9.73	3.77	0.23	−0.51	4	20
Excessive social anxiety	16.58	5.76	0.51	−0.05	7	35
Physical anhedonia	7.47	2.91	0.90	0.91	4	20
Social anhedonia	7.76	2.83	1.30	1.67	5	21
ACIPS-A total score	54.83	7.47	−1.00	1.52	21	68
GHQ-12 total score	22.16	5.29	0.97	0.50	13	41

Note. PQ-B=Prodromal Questionnaire-Brief; ESQUIZO-Q=The Oviedo Schizotypy Assessment Questionnaire; ACIPS-A=The Anticipatory and Consummatory Interpersonal Pleasure Scale-Adolescent version; GHQ-12=General Health Questionnaire-12.

3.4. Latent profile analyses: identification of the latent classes

Among the six latent profile classes, we observed statistically significant differences in terms of gender ($\chi(5)=18.09$; $p=0.003$). Table 4 provides the results of mean scores and confidence intervals (95%) for each latent class. Fig. 1 illustrates the PQ-B, PQ-B distress, ACIPS-A total and GHQ-12 scores as a function of the six latent profile classes. Fig. 2 displays the ESQUIZO-Q subscales as a function of the six latent class solutions.

As indicated on Fig. 1, Latent Class 1 (LC1) displayed low scores on the PQ-B frequency, PQ-B distress, and GHQ-12, and high ACIPS-A total scores. Similarly, on Fig. 2, LC1 displays low scores across all the ESQUIZO-Q subscales. Based on this profile, we identified LC1 as the "low schizotypy, adaptive functioning group".

Compared to LC1, Latent Class 2 (LC2) also displayed low scores on the PQ-B, slightly higher scores on the GHQ-12, high ACIPS-A total scores, and similarly low scores across all the ESQUIZO-Q subscales. However, LC2 participants reported somewhat higher levels of subjective distress on the PQ-B. Based on this profile, we identified LC2 as the "low schizotypy, adolescent angst group".

Table 2
Pearson's correlations between variables (n=449).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PQ-B Distress (1)														
PQ-B (2)	0.92**													
REF (3)	0.41**	0.45**												
MAG (4)	0.45**	0.45**	0.60**											
UPE (5)	0.56**	0.60**	0.64**	0.62**										
PA (6)	0.47**	0.46**	0.50**	0.50**	0.49**									
SPEECH (7)	0.55**	0.51**	0.39**	0.43**	0.53**	0.51**								
ODD BEH (8)	0.40**	0.41**	0.54**	0.42**	0.55**	0.56**	0.50**							
LCF (9)	0.39**	0.41**	0.37**	0.27**	0.37**	0.43**	0.47**	0.51**						
ESA (10)	0.38**	0.34**	0.29**	0.27**	0.30**	0.35**	0.45**	0.46**	0.37**					
PHYANH (11)	−0.15**	−0.17**	0.05	0.04	0.09	0.09	−0.02	0.01	0.01	−0.02				
SOCANH (12)	0.05	0.07	0.29**	0.22**	0.26**	0.32**	0.14**	0.28**	0.23**	0.13**	0.38**			
ACIPS-A (13)	0.02	−0.02	−0.20**	−0.14**	−0.22**	−0.22**	−0.07	−0.23**	−0.18**	−0.11*	−0.34**	−0.55**		
GHQ-12 (14)	0.39**	0.33**	0.12**	0.18**	0.17**	0.25**	0.39**	0.26**	0.35**	0.22**	0.05	0.09	−0.05	

PQ-B=The Prodromal Questionnaire-Brief; REF= Ideas of Reference; MAG=Magical Thinking; UPE=Unusual Perceptual Experiences PA=Paranoid Ideation; SPEECH=Odd Thinking and Speech; ODD BEH=Odd Behaviour; LCF=Lack of Close Friends; ESA=Excessive Social Anxiety PHYANH=Physical Anhedonia; SOCANH=Social Anhedonia; ACIPS-A=The Anticipatory and Consummatory Interpersonal Pleasure Scale-Adolescent version; GHQ-12=General Health Questionnaire-12.

** $p < 0.01$.

* $p < 0.05$.

Table 3
Goodness-of-fit statistics for the one class to six class latent profile solutions.

Models	Log-likelihood value	AIC	BIC	ssaBIC	Entropy	LMR-A	LMR-A *p* value
1 class	−18524.36	37104.73	37219.73	37130.86	–	–	–
2 class	−17695.76	35477.53	35654.13	35517.66	0.93	1639.31	<0.001
3 class	−17514.69	35145.38	35383.59	35199.52	0.86	358.24	0.391
4 class	−17329.81	34805.61	35105.42	34873.75	0.93	365.96	0.210
5 class	−17228.03	34632.05	34993.47	34714.15	0.90	201.36	0.427
6 class	−17227.69	34468.18	34891.20	34564.32	0.92	191.11	0.632

Note. AIC=Akaike information criterion; BIC=Bayesian information criterion; ssaBIC=sample-size adjusted BIC; LMR-A=Lo-Mendell-Rubin-adjusted likelihood ratio test.

Table 4
Mean scores and 95% confidence intervals for the 6-class solution.

	LC 1 (n=173)			**LC 2 (n=126)**			**LC 3 (n=46)**			**LC 4 (n=60)**			**LC 5 (n=20)**			**LC 6 (n=24)**		
	M	*95% CI*		*M*	*95% CI*		*M*	*95% CI*		*M*	*95% CI*		*M*	*95% CI*		*M*	*95% CI*	
PQ-B frequency	1.31	1.03	1.58	5.43	5.11	5.75	9.35	8.82	9.88	10.07	9.60	10.53	3.05	2.25	3.85	14.79	14.06	15.53
PQ-B Distress	2.51	1.72	3.31	13.35	12.41	14.29	23.26	21.71	24.81	30.52	29.16	31.87	6.70	4.35	9.05	47.96	45.81	50.10
REF	4.81	4.49	5.13	6.08	5.70	6.46	11.61	10.99	12.23	5.95	5.41	6.49	11.45	10.51	12.39	11.29	10.43	12.15
MAG	6.69	6.26	7.12	7.76	7.26	8.27	12.83	11.99	13.67	10.02	9.28	10.75	13.65	12.38	14.92	13.79	12.63	14.95
UPE	7.99	7.44	8.54	9.62	8.98	10.26	18.87	17.81	19.93	14.18	13.25	15.12	19.90	18.29	21.51	21.58	20.11	23.06
PA	6.02	5.61	6.43	7.80	7.32	8.28	11.74	10.95	12.53	8.88	8.19	9.58	13.00	11.80	14.20	13.04	11.95	14.14
SPEECH	10.01	9.37	10.65	13.48	12.74	14.23	18.20	16.96	19.44	16.88	15.80	17.97	18.25	16.37	20.13	22.04	20.33	23.76
ODDBEH	5.49	5.14	5.84	7.18	6.77	7.59	10.98	10.30	11.66	6.85	6.25	7.45	11.35	10.32	12.38	11.92	10.98	12.86
LCF	7.43	6.95	7.91	10.42	9.86	10.98	11.76	10.83	12.69	10.83	10.02	11.65	13.50	12.09	14.91	12.96	11.67	14.25
ESA	13.73	12.97	14.50	17.20	16.30	18.09	20.26	18.78	21.74	17.15	15.85	18.45	19.45	17.20	21.70	23.04	20.99	25.09
PHYANH	7.60	7.19	8.01	7.28	6.80	7.76	7.04	6.25	7.84	6.45	5.76	7.14	12.00	10.80	13.20	7.21	6.11	8.31
SOCANH	6.89	6.53	7.25	7.94	7.52	8.37	8.30	7.60	9.01	7.30	6.68	7.92	14.10	13.03	15.17	7.92	6.94	8.89
ACIPS-A	55.69	54.65	56.74	55.21	53.98	56.43	52.04	50.02	54.07	57.47	55.69	59.24	43.90	40.83	46.98	54.54	51.73	57.35
GHQ-12	19.55	18.84	20.26	23.38	22.55	24.21	22.37	20.99	23.75	25.18	23.98	26.39	21.75	19.66	23.84	27.04	25.13	28.95

Note. LC=Latent Class; SE=Standard Error; CI=Confidence Interval; PQ-B=The Prodromal Questionnaire-Brief; REF=Ideas of Reference; MAG=Magical Thinking; UP-E=Unusual Perceptual Experiences PA=Paranoid Ideation; SPEECH=Odd Thinking and Speech; ODD BEH=Odd Behaviour; LCF=Lack of Close Friends; ESA=Excessive Social Anxiety PHYANH=Physical Anhedonia; SOCANH=Social Anhedonia; ACIPS-A=The Anticipatory and Consummatory Interpersonal Pleasure Scale-Adolescent version; GHQ-12=General Health Questionnaire-12.

Latent Class 3 (LC3) displayed considerably higher scores on the PQ-B; in fact, their group mean exceeded the cut-off scores for frequency scales (Kline et al., 2015). Although their mean PQ-B distress scores approached the cut-off score for clinical attention, it did not meet it. Despite this, LC3 appeared similarly to LC1 in terms of their ACIPS-A total and GHQ-12 scores. With the exception of the physical and social anhedonia subscales, the LC3 participants scored high on all the ESQUIZO-Q subscales. This group could be considered a “positive schizotypy group”.

In contrast to LC3, Latent Class 4 (LC4) participants exceeded the clinical cut-off scores for both PQ-B frequency and PQ-B distress. Thus, LC4 participants are displayed high levels of self-reported CHR symptoms. Interestingly, the individuals in this group displayed the highest total ACIPS-A scores, low physical and social anhedonia subscale scores, and average scores on the GHQ-12 measure. Overall, the LC4 group displayed moderate scores on the remaining ESQUIZO-Q subscales. Thus, this profile characterized the LC4 group as a “psychosis high-risk group”.

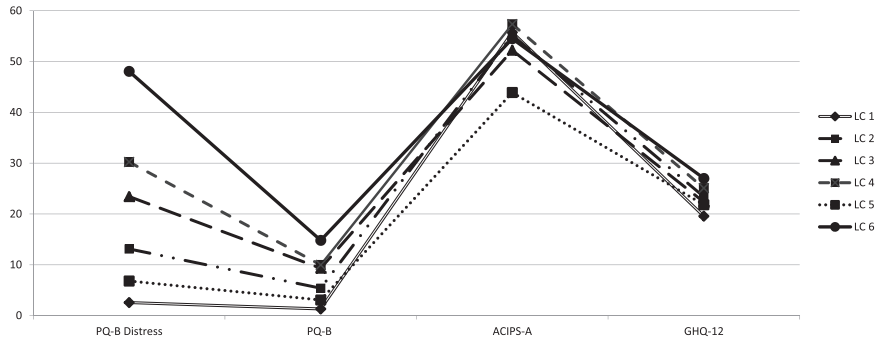

Fig. 1. *Note.* PQ-B Distress=Prodromal Questionnaire-Brief Distress scale; PQ-B=Prodromal Questionnaire frequency scale; ACIPS-A=The Anticipatory and Consummatory Interpersonal Pleasure Scale-Adolescent version; GHQ-12=General Health Questionnaire-12.

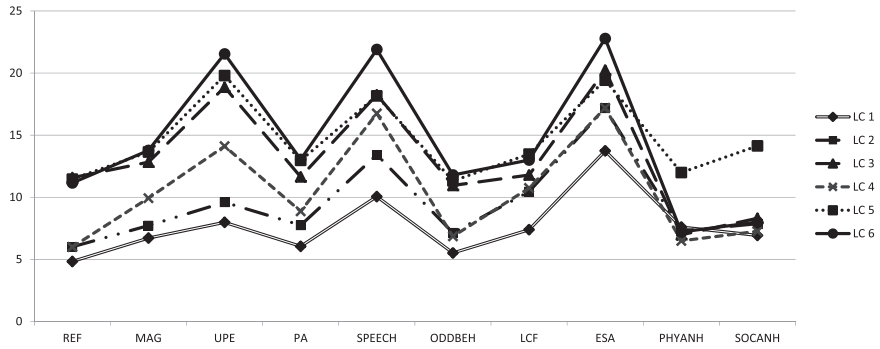

Fig. 2. *Profile of ESQUIZO-Q subscale scores for the 6- latent class solution.* REF=Ideas of Reference; MAG=Magical Thinking; UPE=Unusual Perceptual Experiences PA=Paranoid Ideation; SPEECH=Odd Thinking and Speech; ODD BEH=Odd Behaviour; LCF=Lack of Close Friends; ESA=Excessive Social Anxiety PHYANH=Physical Anhedonia; SOCANH=Social Anhedonia.

As seen in Fig. 1, Latent Class 5 (LC5) appears similar to LC1 in terms of their scores on the PQ-B, PQ-B distress, and GHQ-12 scales. In contrast, LC5 is markedly different from LC1 in terms of the ACIPS-A total score. Indeed, LC5 displayed the lowest ACIPS-A score among all six classes. Consistent with the ACIPS-A score, LC5 also displayed the highest scores on both social anhedonia and physical anhedonia subscales of the ESQUIZO-Q. Fig. 2 also indicates that LC5 displayed high scores across all of the ESQUIZO-Q subscales. As such, we identified the LC5 class as a "high negative and positive schizotypy group".

Compared to LC4, Latent Class 6 (LC6) displayed even higher PQ-B and PQ-B distress scores. As seen in Fig. 1, LC6 reported the greatest amount of subjective clinical distress, as measured by the PQ-B. LC6 participants looked similar to LC4 participants in terms of their ACIPS-A and GHQ-12 total scores as well as their scores on the anhedonia subscales. On all other ESQUIZO-Q subscales, however, the LC6 group displayed greater deviance relative to LC1 than LC4. As a result, we identified LC6 as the "high distress, severe clinical high-risk group".

4. Discussion

Using LPA, we found evidence for six latent classes: two relatively healthy groups, namely, Latent Class 1, the low schizotypy, adaptive functioning group, and Latent Class 2, the low schizotypy, adolescent angst group; Latent Class 3, a positive schizotypy group; and Latent Class 4, a psychosis high-risk group,; Latent Class 5, a high positive and negative schizotypy group; and Latent Class 6, a group characterized as a high distress, severe clinical high-risk group.

These six classes are largely consistent with the at-risk groups identified by other high-risk and early intervention researchers. For example, Cornblatt et al. (2003) identified three at-risk groups, namely, a group with moderately severe attenuated positive symptoms (CHR+mod), a group with severe attenuated positive symptoms (CHR+severe), and a group with nonspecific, attenuated negative symptoms (CHR−). Our findings are also consistent with prior studies of schizotypal traits and features that used a latent class approach. Most of the earlier studies of schizotypal traits (Cella et al., 2013; Tabak and Weisman de Mamani, 2013; Hori et al., 2014) identified at least three latent classes, including one class of individuals who were characterized as displaying low levels of schizotypy and adaptive functioning, and at least two classes of individuals who displayed markedly higher levels of positive schizotypal traits (e.g., unusual perceptual experiences). The three latent classes in the Cella et al. (2013) adolescent sample could be construed as corresponding to some of the latent classes that we identified in our sample. For example, their "low schizotypy" group corresponds to our LC1 or LC2, while their "unusual subjective experiences" group might have fallen into our LC4. Latent Class 4 is characterized as being at moderately high risk for the development of a psychotic disorder, though not necessarily a schizophrenia-related psychosis. Finally, the individuals who would be classified in the Cella et al. (2013) "true schizotypy" class might be classified in either our LC3 or LC5. In the present study, Latent Class 3 and Latent Class 5 both display positive schizotypal traits, though they differ in terms of whether the positive schizotypal traits are accompanied by negative schizotypal traits and/or distress; latent class 3 was labelled the "true schizotypy" class due to these additional features.

Tabak et al. (2013) identified six distinct statistical profiles, including some groups that despite displaying psychometric schizotypy (i.e., "Unusual Experiences", "High Schizotypy") displayed subjective and psychological functioning that was similar to individuals with lower-scoring profiles ("Low Schizotypy", "Average"). In contrast, the two statistical profiles of schizotypy that appeared to be distinctly pathological were both

characterized by negative schizotypal traits, namely "Introvertive Anhedonia", and "Introvertive Anhedonia/Cognitive Disorganization"). Thus, the Tabak et al. study, much like the Cella et al. (2013) study, supports the notion that not all individuals displaying schizotypal traits are functioning maladaptively. Similarly, Hori et al. (2014) identified three latent classes: a low schizotypy/adaptive class, and two high schizotypy classes. The two high schizotypy classes had similar scores on the cognitive-perceptual SPQ factor, but the high schizotypy/maladaptive group also had markedly higher scores on the interpersonal and disorganized factors, in contrast to the high positive schizotypy/adaptive group.

However, our findings differed from the aforementioned studies of schizotypy (namely, Cella et al., 2013; Tabak and Weisman de Mamani, 2013; Hori et al., 2014) in that we focused on psychosis-proneness. As such, we also included measures of prodromal features, which enabled us to also identify a group that displayed CHR symptoms, as measured by the PQ-B total frequency and PQ-B distress scales scores. As Fig. 1 illustrates, the PQ-B distress scale scores clearly distinguish the latent classes. Latent Class 6 displays a markedly higher self-reported distress score than the other five groups; the fact that it is so much higher than even the LC4 suggests that the members of LC6 may be most likely to be eligible for further CHR screening. Indeed, the best course of action would be to follow these six groups over time, especially given the intriguing findings by Geng et al. (2013), who identified 3 classes of individuals based upon their level of schizotypal features and followed them longitudinally over a two-year period. Geng et al. (2013) observed that the medium schizotypal feature group's schizotypal symptoms stabilized during the follow-up period, whereas the symptoms increased in the high schizotypal feature group over time. It is also interesting to note that the ACIPS-A scores also differentiated the latent classes, with LC5 looking distinctly lower than the other groups.

What, then, should be done with the participants in LC5 and LC6, given that they were not treatment-seeking? It is noteworthy that the predictive validity of the ESQUIZO-Q and ACIPS-A in terms of future psychosis spectrum disorders has not yet been demonstrated. At this point, it would not be ethical to label such individuals, though providing psychoeducation about mental health and wellness, as well as resources for further clinical assessment would seem appropriate. Such participants could be invited to return for further research assessment, as well, using a broader array of biologically- and behaviorally-validated indicators, such as the Continuous Performance Task, a test of working memory involving inhibition, or an oculomotor task battery including smooth pursuit eye tracking and saccadic tasks. Such assays would assist in helping to evaluate whether the putatively at-risk individual displayed endophenotypic signs of schizotypy or psychosis-proneness.

4.1. Limitations and caveats

The main limitation of this study is that all of the measures used in the study were based upon self-report. Some might argue that participants are more likely to respond in a biased manner to self-report measures, particularly those pertaining to prodromal and schizotypal symptoms. It would have been helpful to have corroborating information from collateral sources, such as parental reports, teacher ratings, and/or medical records. Clinical interviewing of the participants, particularly those in LC5 and LC6, would have been helpful as well. Furthermore, we were unable to collect data regarding family history of psychosis or any psychiatric illness. Thus, while we were able to identify the presence of some risk indicators, we failed to consider another important risk factor, namely, family history. Similarly, we were unable to collect any information regarding past or present history of drug or alcohol use. Several psychoactive substances, such as hallucinogens and stimulants, provoke psychotic-like experiences; the extent to which the experimentation and/or regular use of these drugs may have resulted in overinclusion of participants in some of the more distressed and/or symptomatic classes (such as LC6) is unclear.

Finally, it should be noted that the latent class approach is a rigorous statistical method which reveals underlying homogeneous groups but cannot indicate their clinical meaningfulness. That is, it would be imprudent to assert that a participant's latent class membership indicated, with any degree of certainty, relative likelihood of developing a psychosis spectrum disorder. The presence of schizotypal traits or CHR symptoms during adolescence is not a necessary or sufficient condition for the later development of a psychotic disorder. However, in a small group of adolescents, these subclinical experiences may interact synergistically and additively with genetic, environmental, and/or psychosocial factors, becoming abnormally persistent and clinically relevant, and lead to the development of clinical psychosis and eventual need for treatment (Linscott and van Os, 2013).

4.2. Conclusions and future directions

Despite these limitations, our study is one of the few investigations of community-derived adolescents using LPA. We adopted LPA and our findings largely supported our hypotheses. We found evidence for six latent classes, that differed in terms of their self-reported CHR symptoms, psychotic-like experiences, schizotypy, trait anhedonia, and mental distress. The six classes of individuals varied in terms of their levels of putative risks for developing psychosis spectrum disorders. These findings may have implications for future early detection and prevention strategies in terms of psychosis spectrum disorders. Longitudinal follow-up of these groups would be desirable in order to confirm whether individuals in the high-risk profiles are more likely to develop psychosis spectrum disorders over time.

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